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ESPRIT Technical Week, Information Technology Forum Day

J.F. Blackburn

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The European Strategic Programme for Research and Development in Information Technologies (ESPRIT) has been reviewed annually since its beginning in 1984. The ESPRIT I was completed in 1988. The ESPRIT II is the second phase of the highly successful ESPRIT program. The Council of Ministers approved a second 5-year phase in April 1988 and 1989 represents ESPRIT II's first year of activity. The ESPRIT II work distribution is Microelectronics - 30 percent, Information Processing Systems - 20 percent, Office and Business Systems - 20 percent. The budget for ESPRIT II is 3.2 billion ECU, shared equally by participating companies and the European Community.

Held in Brussels, the Information Technology (IT) Forum Day of the ESPRIT Technical Week is devoted to speeches of EC and European Parliament speakers and their private industry counterparts who give their assessment of the program. Some of the speakers also present plans.

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Introduction

The European Strategic Programme for Research and Development in Information Technologies (ESPRIT) has been reviewed annually since its beginning in 1984. The ESPRIT I was completed in 1988. The ESPRIT II is the second phase of the highly successful ESPRIT program. The Council of Ministers (Council) approved a second 5-year phase in April 1988 and 1989 represents ESPRIT II's first year of activity. The ESPRIT II work distribution is Microelectronics - 30 percent, Information Processing Systems - 30 percent, Computer-Aided Manufacturing - 20 percent, Office and Business Systems - 20 percent. The budget for ESPRIT II is 3.2 billion ECU, shared equally by participating companies and the European Community (EC).

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Summaries

Opening Remarks, Mr. A. La Pergola, Chair, Energy, Research, and Technology Committee, European Parliament

A fundamental purpose of the EC programs in high technology is to improve Europe's competitiveness in the European and world markets. In the past in some cases, European research and development (R&D) programs have lacked follow-through into useful products or services.

At present, the Framework Program, of which ESPRIT is the largest single program, is at a crossroads. The ESPRIT program can be a giant force for European economics. The new proposal for ESPRIT coincides with the revision of the Framework Program. The new Framework Program will cover 1990-1994, and will overlap the existing 1987-91 program. New funds of 7.7 billion ECUs are being requested to supplement the 3.125 billion ECUs available during the overlap period (see Table 1).

In the Council meeting in December, we will discuss the achievements and concerns of the programs.

Table 1. Framework Program Funding 1990-1994

Program	ECU (millions)
Information and Communications	3,000
Industrial and Materials Technology	1,200
Environment	700
Life Sciences and Technologies	1,000
Energy	1,100
Human Capital and Mobility	700

The ESPRIT program remains the catalyst for other high-technology programs and has played a decisive and innovative role for research. The ESPRIT is successful because its planners overcame skepticism. Because of this program, universities, research institutions, and industry have combined resources. Clearly, other programs have functioned better because of the lessons learned from ESPRIT.

The ESPRIT I program has signaled the birth of trans-European cooperation and fostered the working together of hundreds of participants. The program has contributed heavily to the preparation of standards, for the 1992 European Single Market. However, some problems exist with the extension of this sort of program. In the management of programs, demand outstrips supply, which can damage programs. Programs need more flexibility and more resources. Compared with programs in the U.S. and Japan, European R&D programs have been insufficiently strategic. However, ESPRIT has been the best in this respect. Significant effort has been made to establish European science comparability. Consider the Joint European Submicron Silicon Initiative (JESSI) as an example. The JESSI program is a major EUREKA program for developing dynamic random access memory (DRAM) microchips with a capacity of 64 mbits by the mid-1990s. The main companies involved are Philips, Siemens and SGS-Thomson.

Japan controls about half the world market in memory chips. Our present efforts in this area are not adequate, lacking depth of purpose and demonstrating a gap between politician's words and the funds required for action. The EC members should commit more funds and give a European dimension to R&D.

There is an important role for European companies. The question is how far will they go in cooperation? Cross fertilization is necessary on a global basis, but in so cooperating we should not lose our European identity. We should develop links within Europe. Science and technology (S&T) will be the new building blocks for the European market and the universities should have a

by J.F. Blackburn. Dr. Blackburn is the London representative of the Commerce Department of Industrial Assessment in Computer Science and Telecommunications.

greater voice in the R&D work. Under the Single European Act, there should be consortia between companies and universities to strengthen the contribution to economic growth.

The IT Industry - Meeting the Competitive Requirements of the Nineties, Dr. Horst Nasko, Executive Board Member, Nixdorf Computer and Chair, ESPRIT Advisory Board

When industry advised the EC on the formulation of an action plan, a strategic R&D program was a good idea. However, I had to temper my enthusiasm with realism. Our overseas competitors were continuously expanding their position in the European market. Back in 1983, we had to ask whether a European effort could help and achieve credibility. Today the situation is different; the ESPRIT program is bearing fruit. Concrete technical results are amply shown by the 100 demonstrations taking place outside this conference hall.

The ESPRIT program is an industrial program, conceived by industry for industry. Industry has been the main driving force in defining the research areas, the goals, and the work plans. The aim was R&D that could be used to develop marketable products. European industry and academia have now had 5 years of working together and building mutual trust. Strategy is being more clearly articulated and pursued in a more focused way on a European level.

This is a fitting moment to look at what the future might hold. To gain a proper view of the status of the European IT industry, we need to review recent history. At the beginning of the 1980s, the IT industry low market share led to low R&D and capital investment, and increasing lack of confidence. At the same time, market analysts predicted that U.S. companies would increase their dominance in the market. The analysts were wrong, and European companies have developed a new confidence. Now, on the eve of a period of even more crucial challenges, greater flexibility and foresight is required for consolidating the ground which has been reclaimed.[1]

Most companies have reorganized internally production, marketing, and distribution channels. Throughout the 1980s, cooperation has increased, and the European dimension has become a key element in the strategies of European companies. The ESPRIT program has initiated a pattern for cross-sectoral cooperation. As a result, other programs, such as RACE, BRITE, and EUREKA, have taken up its mechanisms.

The ESPRIT program has created a network of cooperation between European IT vendors, and the process involves more than collaborative R&D. The result is a whole series of improved relations, and a new common attitude has emerged toward standards at all levels. An initiative within ESPRIT led to the foundation of the Standards Promotion and Applications Group (SPAG) and SPAG services with its "Guide to the Use of Standards."

The IT industry has recognized that a strong supply of integrated circuits (ICs) in Europe is crucial. The JESSI program will offer benefits to the computer industry, the telecommunications industry, and to industry as a whole.

Through joint ventures or strategic alliances, there is also more cooperation between hardware manufacturers and software companies. Computer manufacturers are making substantial investments in software to promote the development of new applications, to penetrate new markets, or to offer a wider range of services to the customer.

There are now closer interrelationships between systems suppliers and users. At least one user company participates in 40 percent of ESPRIT projects, contributing knowledge essential for success in the market of products derived from project results. This cooperation must be maintained, for it is through cooperation that European companies better achieve a critical mass of expertise to meet the competitive requirements in the world markets.

The improvement in the IT industry's position has had its foundation in a determined commitment to invest. The combined R&D and capital investments of major European companies has grown faster than that of major U.S. and Japanese competitors in the second half of the 1980s. Combined R&D and capital investments are now at the level of 18 percent of turnover and must be continued.

In addition, in the worldwide market in recent years, European IT companies have been expanding faster than their U.S. competitors. They had a 16.5 percent market share in 1988, well above the 10 percent at the beginning of the 1980s. In the top 100, the IT sales of European companies increased by 17 percent from 1987 to 1988, while the IT sales of U.S. companies increased by 11 percent. IBM's IT sales increased by only nine percent.

European IT companies now hold 43 percent of the European market in information systems compared to 35 percent in 1984. Over the past 5 years, the growth has gone hand-in-hand with industrial restructuring. All IT-related industries, most notably in microelectronics and software, have undertaken merging, acquiring, and rationalizing.

There have been other costs that European companies have had to accept. Along with heavy investment in R&D and capital expenditure, the balance of trade has deteriorated in those components of systems that had to be imported, particularly ICs and peripheral equipment.

Some factors for future change will now be considered. Sophisticated applications and open systems will likely determine the future. Business activity being internationalized is also affecting user requirements. Completion of the European Single Market will surely accelerate the

[1]Of the top 10 IT equipment suppliers in Europe, when ranked by growth percent per year 1984-1987, six are European and three–Nixdorf, Olivetti, and Philips–are at the top of the gorwth.

introduction of new requirements and the demand for new applications. Users will also be demanding more standardized products and will be expressing their preference for open systems, in which they can easily interchange hardware and software components from different vendors.

There is little likelihood of slowdown in the pace of change in technology. Product life cycles, that are now at 2 or 3 years, will likely continue.

The European IT industry is increasingly dependent on the ready availability of advanced microelectronic solutions. European IT industry and other user industries depend on foreign suppliers of critical and strategic components; this is causing concern. Japanese manufacturers produce two-thirds of metal oxide semiconductor (MOS) memory, and this share is nearly 90 percent for 1-megabit DRAMs. This has already pushed U.S. semiconductor and computer manufacturers to unite to establish new production capabilities in the U.S. Also, nearly 90 percent of the production of 32-bit microprocessors is concentrated in three U.S. companies.

Similar supply concentrations also exist for peripheral equipment. Increased attention must be paid to nurturing European manufacturing capabilities to ensure secure supplies and to strengthen the European IT industry as a whole.

There will be increasing pressure to reduce software costs. This is at the top of the agenda in the U.S. and Japan. Over the past 20 years, its price/performance ratio has remained virtually static creating an imbalance in the relative costs of hardware and software. Consequently, increased software productivity is essential.

Recently, the European IT market has grown faster than the U.S. market, and I expect this to continue for the next couple of years. Thus, there will be a limited time window in which vendors in Europe will be able to benefit from this growth which will also attract competitors from abroad. Competition will be tougher on every level of the IT market.

Conditions for fair competition must be maintained. There is a growing and worrying tendency to engage in a subsidy race to attract new installations from overseas firms. The strengthening of overseas competitors in the expanding European market should not be accomplished with European taxpayers' money.

In preparing for the future, human resources is the first major problem to be tackled. There is a critical lack of trained personnel. In the Federal Republic of Germany, the annual need is for an estimated 6,000 engineers trained in very large-scale integration (VLSI) design. At present throughout the EC, only about 2,000 per year are entering the work force. The EC members must adapt the structures of education and training at both the professional level and the level of the most qualified researchers and scientists.

In the competitive environment, EC members must remain determined. They must provide an environment in which industry can achieve its full potential, and where demand can evolve and expand.

The viability of the European IT industry in the nineties will be influenced by opening the telecommunications market, and introducing a wide range of new products and services, including high-definition television (HDTV) and Integrated Broadband Networks. By using advanced IT and telecommunications, by applying traditional methods and skills, by investing resources in R&D, and by studying user needs, we will be better able to manage the introduction of the new trans-European systems and applications on a wide scale and in the new areas. I welcome the conception of the European Nervous System to address some of the needs. The European Nervous System has been put forward to the Internal Market Council and will, in its R&D aspects, be a part of the new Framework Program.

The deregulation within telecommunications in Europe is a major milestone of 1992, with a high potential for economies of scale and cost reductions. In the interim phase, there will be inevitable distortions, imbalances, and restructuring in our industry. We are prepared for this, but we are not willing to decline to a purely European scale. Our thrust is the worldwide market, based on international standards.

For 1990-1994, the third Framework Program of EC R&D is being discussed. In IT, there is a consensus of industry and science concerning the topics that must be given priority.

Technological dependencies must be addressed, particularly in microelectronics and peripheral equipment. Software productivity must be increased and open systems will be a key issue. Through the ESPRIT Advisory Board, industry and science have made proposals on these needs and they have been presented to the European Commission (Commission).

Industry is ready to face the competitive requirements of the coming decade, but time is short. I therefore appeal to the 12 Ministers of Research for a quick decision on the new Framework Program. Let EC industry and science have a mutually agreed-upon set of priorities for the new decade, to strengthen and enhance our position in the world market.

ESPRIT '90s: A More Complementary Approach Between Producers and Users of Information Technology to Respond Better to the Demands of European Society and Economy, Dr. Umberto Agnelli, Vice Chair, Fiat

The ESPRIT program may be considered a symbol of Europe's awakening and of that revival in the process of European integration that will soon give birth to the Single European Market. The program was the first action taken to combat the widening technological gap dividing Europe from the U.S. and Japan and signalling that the 12 governments intended to reach an agreement that would reinvigorate the integration process. The ESPRIT was the prelude to a series of decisive develop-

ments, including the Single European Act and the subsequent goals that are taking us toward 1992.

The new ESPRIT programs have trained their sights on people and the quality of life, as well as on industrial competitiveness. Soon, ITs must be used increasingly to integrate factories and offices, design with the production process, and the company with its suppliers. However, a new objective for IT of the nineties is to be used to handle changes in complex systems--environment, mobility, welfare, cities, quality of life, and economic growth. Slower growth in the hardware and software markets are because of companies and societies making too restrictive use of IT. In big companies, computers play a very important role in managing the day to day operations. In Fiat, we have carried out advanced experiments in factory automation. Recently, we have begun to adopt an extended enterprise approach to IT, dealing with suppliers, transporters, and the market.

Doubtless, the real revolution has yet to happen in European companies. When it happens, IT will make it possible to achieve total factory and office integration and will cover all the various functions from design to production, and control in manufacturing complex products such as the car. The change will require not only a technology push from the computer manufacturers but also a needs pull that will depend on the users' ability to respond appropriately to the demand for integrated systems. Once we are able to extend the use of IT and telematics, in particular, to creating a new way of living and working, that demand undoubtedly will increase. This means that ESPRIT should serve not only the IT business, but should also help IT to fertilize all other businesses and society.

The ESPRIT is underused by companies whose core business lies neither in IT nor in telematics. The ESPRIT needs to accentuate its efforts by:

- Having IT and telematics users participate to a much greater extent than today
- Developing common standards that will permit the integrated handling of different systems and languages
- Paying greater attention to the opportunities provided by IT, but are found upstream or downstream from computer applications.

The ESPRIT program of the eighties offered decisive financial support for research aimed at the producer-oriented development of IT. The ESPRIT program of the nineties should also support research for user-oriented IT. To satisfy the emerging demands of business and the quality of life, we need alliances between major producers and the major IT users. The ESPRIT program could be the catalyst of synergies, and should have a significant influence on standards.

The ESPRIT must establish open systems. The scope of ESPRIT must be broadened to grasp opportunities upstream and downstream of IT use. For example, Computer Integrated Manufacturing (CIM) involves everything upstream. We need to organize work and production so IT is used maximally in terms of productivity, quality, and flexibility.

Two other problems are having a negative impact on the efficacy of research into and application of IT:

(1) The ESPRIT program goes no further than the development of precompetitive prototypes. The time may have come to extend the ESPRIT umbrella to the threshold of industrial application.

(2) Neither ESPRIT nor other EC research programs can ignore the problem of the lack of harmony within the EC of fiscal incentives for R&D expenditure.

The society of the nineties needs the widespread dissemination of IT, and ESPRIT must play a major role in providing a European response to that need. The IT users and producers must get to the real issue and become more complementary to acquire strength.

Reflections, Viscount E. Davignon, Chair, Societe Generale de Belgique

I have been called the father of ESPRIT, but I am probably more appropriately called the grandfather. The ESPRIT program has increased the links between scientists and businessmen. Aside from the technological aspects, this catalyzing role played by ESPRIT is important. The ESPRIT program's important role will stand as a great effort that has made up for lost time and that met an existing need.

The catalytic role that ESPRIT played could not have been met by any national organization. The market follows the needs of customers and is not linked with national borders. The financial support provided through ESPRIT was not the fundamental reason for the involvement of a participant. If that were the main reason, then maybe we should go back to the traditional (national) support. I do not think that is the case.

We believe that IT, guided by the market and cooperation in Europe, has still a long way to go to be comparable to the U.S. and Japan. We in Europe are not at the head of the line. However, things work differently in Europe; we can't work strictly on a unilateral basis. We must recognize that certain structural handicaps and vagueness causes complications. However, we need to simplify those complications where possible.

Let us consider now the rules of the game for ESPRIT. Should it be limited to Europeans? If so, what is to be the criterion for European? Companies will increasingly have international stockholders. Can the company's incorporated location be the answer? I think it is important to make sure the work is done in Europe. What is our undertaking about our competitors from overseas? Can the Americans be involved? If we decide to include the U.S., then should we include Japan? Reciprocally, can we be involved in both American and Japanese projects?

We must discuss the extent of international cooperation; we need standards and open systems.

Without international cooperation, we may lose some of the benefits we now have. Reciprocity is difficult to define. If we use public funds, there can be a sort of balance between the pros and cons of reciprocity. Let's not use reciprocity as an excuse for noncooperation. In international cooperation, we must take the initiative.

One important task before the Commission on R&D will be its contribution to buildup of competence. We need to prepare for the expected situation in 10 years. Also, we know the EC members' budgets and must look closely at the situation in the short term as well. Members tend to view situations in the short term, so the Commission must take the long-term view. In this connection, it is important that the major men of science advise on where we are going to be in 10 years. One question is what will be achieved in R&D in 10 years? We can look back 10 years to the situation in Japan, then compare it with their situation today.

We need cooperation in going from the short-term planning of the past and the required long-term planning now. The Commission is in a unique position to push ahead. A key factor for the universities of the future will be the capacity to define what others' programs will do.

When I was with the Commission, Michel Carpentier and I noted that certain pilot projects superseded one another. We are not joking about pilot projects anymore. New projects must stimulate what has not been done. In Europe's future, committees have a very important role to play. To make a real contribution to Europe is a long-term option.

Panel of Experts Questions and Answers

Question: Japanese challenge and the MITI role, Dr. H. Nasko.

Answer: The role played by MITI in Japan would not apply in Europe. There is a genetic difference between European and Japanese societies. I suggest we, in Europe, follow the process mentioned by Viscount Davignon, to use the catalytic process and apply standards. Industry then joins in voluntarily.

Question: Improving the effectiveness of ESPRIT, Dr. P. Aigrain, France.

Answer: There has been an evolution. At the outset, companies were not accustomed to working together; but they learned that it was good in any case. There was an advantage in sharing R&D cost. Through sharing, the work could be accomplished more effectively than could be done through working alone. When we moved to ESPRIT II, we found that companies were more willing to work together on strategic projects. This was a new spirit not present in ESPRIT I. We are now moving toward larger-scale projects and projects closer to the market. There are more long-term projects as well as basic research projects. The program is not rigid; it has been expanded in both basic research and the market.

Question: Symmetry and parallel openness in the U.S., Mr. M. Carpentier, Director General, DGXIII, European Commission.

Answer: After Davignon's speech, this is a dangerous task but I agree with him. The Japanese are very drawn to Europe, and we are getting a little bogged down on Japan-bashing. We should look at the advantages of cooperation; for example, consider the Japanese on mobile communications.

The roundtable of 12 members tells us that we should look more cleverly at the openness of the U.S. markets. While initially open, I believe they are closing. Americans are confusing Europe and Japan on HDTV, for example.

F.M. Pandolfi, Vice President of the European Commission

I think it useful to stress certain points, to understand the strategy being followed, and to give an overview. The four topics that I wish to consider are: The Gift of History, Ambiguity, Response, and The Rules of the Game.

The Gift of History. In Eastern Europe, the forecasts of the political scientists have been confirmed by events. There are now millions of people whose status has completely changed. The process should continue in a gradual and balanced way. An open question is to what extent there will be obstructions. The Council discussed the subject, and clearly these changes add another priority to the EC's present one. Perhaps more priority requires a continent-wide response.

The EC needs a center of gravity and must avoid the risk of Balkanization. There must be freedom to deal with the German unification issue and with continent-wide responsibilities. If we strengthen the EC, it will help achieve our Europe-wide responsibilities. Therefore, we have a duty to strengthen the community and to implement the Single European Act.

Ambiguity. The strategic objective of the plan for 1992 is to improve opportunities for Europe, which should lead to an increase in gross domestic product. There is some risk that it may be misunderstood, as some may think of it as Eurodeterminism leading to automatic results.

There is a need for some new policies. For example, the EC's R&D policy is one of the policies of the central market. We must be frank and responsible and look at the dangers.

Americans Talk of Fortress Europe. Our consciences are clear on this point: that is not our objective. The Japanese are very clever and they and others may be moving to head off some of the consequences of the Single European Market. We must balance international cooperation and international competition. Otherwise, we risk becoming mainly a big consumer market. We must have a center of gravity and we must develop our supply strategy and our strategy for S&T.

Response. A courageous decision was to achieve a new Framework Program to go beyond 1991 and on to 1994, with a 2-year overlap with the present program. This action gives the impression of a community that grasps its responsibility. The focus of the program is on several specific lines. (Note: See Note under speech of La Pergola, the first speaker.) A very important line is Information and Communications. The Framework Program is guided by the idea of the importance of IT which impacts across the board of industries. For the Framework, 7.7 billion ECUs were requested in addition to the 3.125 billion ECUs available during the overlap period. A third subprogram under Information and Communications after ESPRIT and RACE will be called Structuring Technology.

We face several global problems; e.g., terrorism, but we cannot work in isolation and have an efficient network.

Rules of the Game. What form should the Commission intervention take; not in industry strategy but in harmonizing and liberalizing? We can achieve these and play a vital role in the large internal market. We can play a major role through education, training, and university involvement. The EC must accept and apply its responsibilities; i.e., to do what cannot be done at the national level.

In telecommunications, an important consideration is to determine what equipment and services should be liberalized. Another matter is to allow packet- and circuit-switching to coexist. Finally, we must support a European market.

Brief Summaries

Information Processing Systems and Software, Professor D. Tsichritzis, Director, Computer Center, Geneva, Switzerland

I would like to see happen in the future in this area:

- Active participation of the users on the definition of platforms and standards to shape future computer systems, including architecture, programs, file systems, and related activities.
- Productivity of software development will increase through development, dissemination, and use of modern tools and methods. More training is needed; it is wasteful to develop software that must be thrown away.
- Remote and small organizations will be an integral part of software development and distribution. We need small- and medium-sized enterprises and those even widely distributed geographically.
- Basic research will continue to provide us with pride, results, expertise, and experts for future development.
- The will to turn dreams into possibilities and take the steps required to turn possibilities into capabilities.

Office and Business Systems and Peripherals, I. Di Robien, Director, Bull Computer

In the car industry, there are variations in the product, but there is a standardized platform, modules, and software. We can draw some analogy with office and business systems.

In 1985, there were about 55 million white collar workers in Europe and we expect that number to grow to 70 million by 1995. This will provide an enormous increase in the market for office systems, including workstations and networks and their integration. Issues that are being raised include security of information and network management.

We need a strategy to provide standardized platforms. At least a part of the solution is to have open systems and system transparency. Manufacturers will want and need some product differentiation, as in the car industry. We can achieve this through pushing new applications and offering ways to integrate within and between enterprises.

On the subject of peripherals, Europe has a $17-billion deficit in data processing products. Two-thirds of this is caused by importing personal computers and one-third by importing peripheral equipment.

Computer Integrated Manufacturing, Mr. P.G. Motta, Chief Executive, Technation

In this industry, there is a need for R&D beyond the work in ESPRIT. The objective of such additional research is to build competence covering the entire engineering industry. Of course, we must exploit ESPRIT results to achieve an improved technology base. A multivendor open system has been demonstrated as an important contribution to standards. There has been reliable European cooperation and increased technological awareness as a result of the ESPRIT program.

There is an unsaturated worldwide market for computer-integrated manufacturing systems. The European market is large--26 percent of the world market. Also, there are new market opportunities in new applications; e.g., mining and agriculture. The strengths of Europe in this industry include expertise in components, the manu-

facturing industry, and a high level of engineering background and experience. Competition from the U.S. and Japan will be strong because of a higher increase in R&D, a large home market, and a strong market position in some areas (see Table 2).

Table 2. Computer-Integrated Manufacturing Objectives

- To stimulate the engineering industry with IT
- To implement results and focus strategy on market opportunities
- To respond to public pressure for environmentally friendly industrial operations.

Microelectronics, Mr R. Van Overstraeten, President, IMEC

In the microelectronics industry, Philips is the only European company in the world top ten. However, the European position is improving. In the future, the concentration will be on wafer scale integration, 3-D integration, other new materials, depth of junctions and smaller devices, etching process, use of automation, use of robotics, manufacture of application-specific integrated circuits, and very large memory chips.

The single largest effort in microelectronics in Europe is the JESSI program. The program's technical objectives and concepts include technology, equipment and materials, and applications and basic research. Briefly stated, JESSI's mission is to develop submicron silicon process technology, as well as manufacture and design capability by 1995. The program objectives will include developing the technology to produce memories and logic using 0.3 micron feature size by 1995. Existing 4-megabit DRAMs use 0.7 micron circuits, the future 16-megabit DRAMs are expected to use 0.5 micron circuits, and the 64-megabit DRAMs of 1995 will use 0.3 micron circuits.